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Examining the contribution of climate change on global soil moisture drought characteristics

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Drought is commonly perceived as a natural hazard that evolves gradually. However, the recent increase in both the onset rate and severity of these events has drawn significant attention [1]. Both climate change and human activities contribute to the alteration of drought characteristics, affecting their development speed and intensity. For instance, climate change may indirectly influence droughts through alterations in the amount and distribution of precipitation and evapotranspiration, whereas human activities like land management can directly impact soil water content. This study employs the ISIMIP Global Water models [2, 3], driven by the hypothetical stationary ISIMIP3a climate dataset without climate change, and transient land use changes based on empirical observations [4]. We utilize soil moisture as an indicator of water deficit and a method to calculate the hydrological drought propagation speed to delineate drought characteristics. We contrast these results with those from historical simulations that include climate-related forcings based on empirical data to assess the historical long-term changes attributed to climate change. Our findings indicate that climate change significantly affects the development speed and intensity of droughts. Regions such as the rainforests of South America, Europe, and Southern Australia are identified as hotspots of more aggressive droughts, whereas areas like the East African mountains might experience milder droughts due to climate change. These variations could critically affect agricultural productivity, ecosystem health, and water availability for human consumption. The potential future acceleration of droughts underscores the importance of enhancing risk management and challenges existing drought hazard prediction research and practice.

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